parallel to the first axis and protruding from the ladle toward the mold.

17. (Amended) The machine of claim 13, further comprising pressure gauges [intermediate the structure and] connected to the control means [for terminating the teeming operation in response] and responsive to changes in the weight of the teeming ladle.

19. (Amended) The machine of claim [13] 18, wherein the teeming ladle is provided with a slag brick adjacent to the [spout] spouting stone. 4.

Please cancel claim 16.

Remarks

With a view to expediting the prosecution Applicant is submitting herewith two versions of a substitute specification (one showing the changes by brackets and underlinings, the other one being plain) which incorporates all the changes outlines in Applicant's Preliminary Amendment of 27 December 1999. These changes merely seek to improve the English idiom of the text and do not add new matter to the original disclosure.

In view of the fact that the instant application was filed with drawings identical to those of WIPO publication WO99/00205 = PCTCH98/00261, Applicant does not understand the Examiner's request under point 1 of his Official Action.

The rejection of claim 10 under 35 U.S.C. 112 is believed to have been rendered moot by the above amendment to the claim. The unfortunate confusion in the original claim in respect of the mold is regretted; but the Examiner's proper interpretation of the claim for purposes of 35 U.S.C. 103 is appreciated.

That the rejection of Applicant's claims 1-17 and 19 under 35 U.S.C. 103

over JP 08141732 (Tomoyuki) in view of Sato's U.S. patent would seem to be untenable, however, as it is based on a misinterpretation of Applicant's invention or of the teaching of those two references.

Applicant has amended his claims 10, 11, 13, 17 and 19, and has canceled claim 16. It is urged that the amended claim, by defining the three movements of the teeming ladle as taking place simultaneously, clearly sets Applicant's invention patentably apart from the references, singly or in combination. Neither Tomoyuki nor Sato teaches a teeming ladle with a protruding spout curved about a theoretical fulcrum. Nor does either reference teach treble-component movement of a teeming ladle for the purpose of maintaining constant the trajectory, as it were, of the molten metal pouring from the spout as the ladle is increasingly tilted or pivoted. This novel combination of protruding spout and simultaneous three-fold movement (horizontal, vertical and pivotal) of Applicant's teeming ladle makes it possible to service, with as close a spacing between the ladle and the mold as possible, even such molds the teeming funnels of which are recessed from the forward margin of the mold. It respectfully pointed out to the Examiner that Tomoyuki's and Sato's teeming ladles do not allow for such spatial proximity between ladle and mold as neither suggests, much less discloses even the possibility of using a protruding, i.e. elongated teeming spout.

Mutschlechner et al., U.S. Patent 4,817,919, teaches nothing which would be of assistance to anyone seeking to devise a teeming ladle capable of performing in the manner of Applicant's apparatus. The '919 reference teaches a converter for metal processing and for casting which is pivotable about an axis at rather a large radius for the purpose of being disposed upside down. For casting it is pivotable at a small radius. It is not understood in what manner the '919 reference can reasonably be said to contribute anything to solving the problem overcome by Applicant's invention.

As regards the teaching of Szadkowski, U.S. Patent 5,170,915,

Applicant's claim 18 merely narrows a preceding claims and ought to be allowable as a typical subclaim.

It is earnestly urged that as now amended the instant application is in condition for allowance which is courteously solicited.

A clean copy of the claims as amended is also enclosed.

Respectfully submitted,

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Area Code (617)-491-8867

Claims, amended 5 November 2001

1 ~~10~~. (Amended) A method of controlling the pivoting movement of a teeming ladle about a theoretical fulcrum relative to a teeming funnel of a mold of a substantially linear array thereof and provided in a first teeming machine adapted to be moved in a first direction parallel to the array, the ladle comprising at one side thereof a protruding spout provided with a teeming channel of predetermined radius curved about the fulcrum, comprising the substantially simultaneously executed steps of:

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moving the ladle toward the mold in a second direction substantially normal to the first direction for placing the spout over the teeming funnel;

lifting the ladle in a third direction substantially vertically relative to the first and second directions; and

pivoting the ladle about an axis intermediate the one side and a side opposite therefrom and extending substantially normal to the second direction.

2 ~~11~~. (Amended) The method of claim 1 ~~10~~, wherein the moving, lifting and pivoting movements are executed by motors under preprogrammed electronic control means.

3 ~~12~~. The method of claim 2 ~~11~~, further comprising a second teeming machine adjacent the first teeming machine for continuing the teeming operation when the ladle of the first teeming machine is empty.

13. (Amended) A teeming machine, comprising:

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a first carriage mounted for movement in a first direction substantially parallel to a linear array of molds;

a second carriage mounted on the first carriage for movement relative to the array of molds in a direction substantially normal to the first direction;

a structure extending upwardly from the second carriage and supporting retaining means for movement substantially vertically of the first and second directions;

a suspension plate mounted on the retaining means;

means for pivoting the suspension plate about a first axis extending substantially parallel to the movement of the first carriage;

a teeming ladle releasably mounted on the suspension plate and provided with an elongated teeming spout curved about a second axis parallel to the first axis and protruding from the ladle toward the mold.

5 ~~14~~. The machine of claim ~~13~~ 4, further comprising a first motor for moving the second carriage, a second motor for vertically moving the retaining means and a third motor for pivoting the suspension plate.

6 ~~15~~. The machine of claim ~~14~~ 5 wherein said means for actuating comprises ~~further comprising~~ a programmable electronic control for controlling the movements of the first, second and third motors.

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17. (Amended) The machine of claim 13, further comprising pressure gauges [intermediate the structure and] connected to the control means [for terminating the teeming operation in response] and responsive to changes in the weight of the teeming ladle.

8 ~~18~~. The machine of claim ~~13~~ 4, wherein the spout of the teeming ladle is provided with an exchangeable spouting stone.

19. (Amended) The machine of claim [13] 18, wherein the teeming ladle is provided with a slag brick adjacent to the [spout] spouting stone. 4.

[SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT I, FRITZ LAUPER of Hauptstrasse 313B, CH-3266 Wiler bei Seedorf, Switzerland, a Swiss citizen, have invented certain new and useful improvements in METHOD AND DEVICE FOR THE MOVEMENT CONTROL OF A TEEMING LADLE WITH A LOW TEEMING HEIGHT IN A TEEMING INSTALLATION of which the following is a specification:]

Method and Device for Controlling the Movement of a Teeming Ladle Having a Lof Teeming Height in a Teeming Installation Device

BACKGROUND OF THE INVENTION

1. Field of the Invention.

The present invention relates to a method [for] of controlling the movement [control] of a teeming ladle [according to the preamble of patent claim 1] and to a teeming machine for carrying out the method[, according to the preamble of patent claim 4].

Existing automatic foundry installations for the repeated controlled filling of liquid metals from a tiltable ladle into successively furnished moulds [supplied after one another] function in the following manner: the molten mass during the teeming runs via a spout stone [with a] of radius R out of the ladle, wherein the tilting axis of the ladle [runs] extends at least approximately through the centre of this radius, the so-called theoretical point of rotation of the spout, [in a manner] such that independently of the tilting angle of the ladle approximately equal geometric and thus flow design relationships are to be achieved. The tilting is effected via a controlled drive which via mechanical connection members engages the ladle.

With such installations one achieves an excellent running of the teeming procedure when teeming [on], during the teeming and [with] at the completion of this. However such installations [have] suffer from the

disadvantage for teeming [with] at a relatively low teeming height the teeming funnel must lie [in the region of] near the edge of the mould box. With teeming funnels [lying] positioned further inside and whilst maintaining the required defined safety distance of the ladle body with respect to the mould box, [caused by] the teeming height increases because of the segment shape of the teeming ladle[, the teeming height increases].

Since teeming funnels [lying] positioned far inside the mould box may [be insufficiently] not be reached in a satisfactory manner, the funnel must be pulled to the edge which with existing models leads to [expensive changes. With] costly modifications. In moulding boxes with weighting iron, [often] the weighting iron must often be modified which again leads to additional cost. However since on the models or weighting irons, changes may not always be carried out, on account of the high teeming height one may only teem with an extended teeming spout. Such a teeming spout is however not suitable for the automatic teeming and with manual teeming can be handled only with difficulty.

From EP Patent 592 365 there is known a teeming method in which the teeming ladle, after the first teeming [procedure] operation, and because of a stationary tilting axis may be displayed further towards the middle of the teeming mould, whilst maintaining a certain safety [distanmce] distance of the teeming ladle with respect to the teeming box[, with the help of a stationary tilting axis may be displaced further towards the middle of the teeming mould]. With this method the stationary tilting axis with the lift drive is attached at the front on the teeming spout and since the tilting bearing required on the tilting axis must likewise be located at a safety distance over the teeming box or the weighting iron, this leads by way of design likewise to a large teeming height. A large teeming height however causes considerable disadvantages; since more kinetic energy must be destroyed a deeper teeming funnel becomes necessary so that the top box may not be optimally exploited. Furthermore

more circulation material is required, there is more splatter iron, a more erratic teeming with more turbulence in the funnel, and more sand rinsings [amd] and more sand and gas enclosures are to be expected. With mould boxes with weighting iron the teeming height is increased further since the tilting bearing must lie above the weighting iron.

BRIEF SUMMARY OF THE INVENTION

It is thus [the] an object of the invention to avoid all mentioned disadvantages and to [provided] provide a method and a teeming machine for controlling the movement [control] of a teeming ladle, with which one may always teem [with] at a lower teeming height even when the teeming funnels are arranged at any location in the mould box, and with which the theoretical point of rotation of the spout is stably guided into the lowest possible position. This object is [now] achieved by the method and the teeming machine [which comprises the characterising features of patent claim 1 and 4] as hereinafter set forth in greater detail. [Advantageous embodiment forms of the subject-matter of the invention are specified in the dependent patent claims 2, 3 and 5.]

BRIEF DESCRIPTION OF THE DRAWINGS

Hereinafter, a preferred [one] embodiment [example] of the invention is described in more detail by way of the schematic drawings[. There is shown], in which:

Fig. 1 [a lateral] is a side elevational view of the teeming machine

Fig. 2 [a plan] is a top elevational view of the teeming machine shown in Fig. 1,

Fig. 3 is a view of the teeming ladle in the teeming position and

Fig. 4 is a [scetched] sketched detail of the teeming ladle suspension.

DETAILED DESCRIPTION OF THE INVENTION

According to Fig. 1 the teeming machine 1 on wheels 2 of a longitudinal [vehicle] carriage 3 is [traversable] horizontally movable on rails 4 in a direction Y, parallel to a teeming mould path indicated at 5[, horizontally in the Y-direction]. The longitudinal [vehicle] carriage 3 [carries] supports a transverse [vehicle] carriage 6, which by way of rail guides 7 is [displaceable] transversely [to this] displaceable in a direction X by way of a friction motor 8 [in the X-direction]. On the transverse [vehicle] carriage 6 there is mounted a tower-like [construction] structure of the teeming machine and its control cabin 10 with the electronic control means 11, with an intermediate arrangement of pressure fluid gauge chambers 12. In the [construction] structure 9, there is provided a retaining means 13 for the teeming ladle 14 for moving it up and down in the vertical direction Z [is liftably and lowerably arranged]. The retaining means 13 is suspended on a chain 15 which is displaced via chain wheels 17 driven by a lift motor 16. In the retaining means 13 there is mounted a tilt shaft 18 which is rotatable about an axis A and which is driven by a tilt motor 19. The tilt shaft 18 pivots a protruding suspension plate 20 in which the teeming ladle 14 is suspendably fastened.

[On] During operation of the teeming machine the longitudinal [vehicle 3 with] carriage 3 and the teeming ladle 14 filled with moulten metal mass is [traversed so far] moved in the Y-direction until the teeming spout 21 at the height of the teeming funnel 22 is opposite the teeming mould 24 loaded with the weighting iron 23 and which is to be cast, which is effected by the electronic control means 11. The electronic control means 11 is provisionally programmed corresponding to the dimensions of the teeming moulds to be cast. According to the programm which is to be called up the friction motor 8, the lift motor 16 and the tilt motor 19 are controlled in a manner such that the theoretical point of rotation of the spout D with the radius R of the spout stone

25 moves on the curve K1 from above to below which always corresponds to the lowest possible teeming height whilst observing a safety distance. For this the engagement point K of the tilting moment transmitted by the tilt shaft 18 via the suspension plate 20 onto the teeming ladle 14 must move on the curve K2 correspondingly from bottom to top, which is effected by the suitable control of the mentioned motors.

By way of the pressure fluid gauge chambers 12 functioning as weighing cells the teeming procedure may be automatically stopped by the control means 11 in dependence on the cast molten mass weight and may be [reassumed] resumed with the subsequent teeming mould. With this the electronic control means is programmed such that the lifting and lowering of the teeming spout is carried out in the fast mode during the teeming pause which is to be kept as small as possible. Until the curves K1 and K2 are passed through and the teeming ladle is thus emptied, in general several teeming moulds may be filled. With the empty teeming ladle the teeming machine must traverse to a loading and unloading station where the empty teeming ladle is replaced by one which is full. Thereupon after traversing back the teeming procedure may be reassumed. In order to avoid such a temporal interruption in teeming, two teeming machines may be arranged next to one another so that [with an empty] when the teeming ladle of the first teeming machine is empty the second immediately continues the teeming [procedure] operation whilst the first one replaces the empty teeming ladle with a filled one [which is full]. The only condition to this method is that the loading and unloading station can be reached in both directions of the rails 4.

With the protruding suspension plate 20 it is possible for the first time to fasten the teeming ladle only on one of its lateral surfaces and to tilt it. This is achieved with protruding coupling parts 26 and 27 [above] on the teeming ladle, wherein the part 26 with a [part] partially circular recess 28 engages into an axle [journal] stub 29 and the part 27 into an opening 30 of the

retaining plate 20 by which means the teeming ladle is suspended on the retaining plate. For [the] its lateral stabilisation the teeming ladle 14, with a rounded [projection] protrusion 31 [,] below rests on a protruding part 32 of the suspension plate 20. With this suspension of the teeming ladle [there results] numerous advantages results, thus the teeming machine may be designed smaller, the accessibility between the teeming ladle and teeming mould is improved, only a vertical drive in the Z-direction and a tilting drive about the axis A is necessary, a rotational drive for exchanging the ladle is made possible, by which means this exchange is greatly accelerated and ladles of varying size may be applied.

The spout 21 of the teeming ladle 14 is equipped with an exchangeable spout stone 25. In this manner the stone may be kept smaller and more economical;[, with the ladle exchange] it may be simply and quickly exchanged whenever a ladle is changed and fireprooof material is saved. The exact [application] insertion of the spout stone is effected by a [mounting attached in] bracket mounted on the snout so that the radius of the spout stone on teeming moves exactly about the theoretical point of rotation of the spout D, by which means teeming flow fluctuations during the complete tilting procedure are avoided.

For holding back the slag, for breaking the waves and for [destroying] absorbing the kinetic energy arising in the ladle by way of the tilting in the vicinity of the spout 21 there is applied a specially formed slag brick 33.

With the described teeming machine practically each and every [teeming] cast object may be teemed [independently] regardless of the [accompanying] height of an associated mould box [height], since with a model change the [electronical] electric control means [must] have to be [correspondingly newly programmed so that] appropriately reprogrammed to match the curves K1 and K2 [are matched] to the new model.

[CLAIMS] What is claimed is:

1. A method for the movement control of a teeming ladle about a theoretical point of rotation of the spout with at least one teeming machine traversable parallel to a teeming mould path, wherein the teeming ladle during the whole teeming procedure is moved relative horizontally in an X-direction and vertically in a Z-direction and is pivoted about a rotational axis A.

2. A method according to claim 1, wherein an electronic control means of the teeming machine is programmed with the movements in the X and Z direction and with the pivoting about the rotational axis A and is called up for control of means effecting the movements and the pivoting on teeming.

3. A method according to claim 1 or 2, wherein two teeming machines are arranged next to one another, wherein the second teeming machine continues the teeming process when the teeming ladle of the first teeming machine is emptied.

4. A teeming machine for carrying out the method according to one of the claims 1 to 3, with a longitudinal vehicle traversable on rails, wherein on a transverse vehicle (6) displaceable transversely to the longitudinal vehicle (3) there is arranged a tower-like construction (9) in which there is provided a vertically movable retaining means (13) with a suspension plate (20) for the teeming ladle (14), said suspension plate (20) being connected to a tilt shaft (18) rotatably mounted in the retaining device (13).

5. A teeming machine according to claim 4, wherein the transverse vehicle (3) is provided with an electronic control means (11) arranged in a control cabin (10), said control means being controllably connected to a friction motor (8) for displacing the transverse vehicle (6) on rail guides (7), to a lift motor (16) for lifting and lowering the retaining means (13) by way of

chains (15) and to a tilt motor (19) for driving the tilt shaft (18).

6. A teeming machine according to claim 4 or 5, wherein the teeming ladle (14) with two coupling parts (26 and 27) protruding on its sides can be suspended in corresponding counter pieces (29 and 30) of the suspension plate (20).

7. A teeming machine according to one of claims 4 to 6, wherein the tower-like construction (9) and the control cabin (10) are mounted on the transverse vehicle (6) with the intermediate connection of pressure fluid gauge chambers (12).

DUPLICATE

8. A teeming machine according to one of claims 4 to 7, wherein the teeming ladle (14) is equipped with an exchangeable spout stone (25).

9. A teeming machine according to one of the claims 4 to 8, wherein the foundry ladle (14) in the vicinity of the spout (21) is provided with a slag brick (33).

ABSTRACT OF THE DISCLOSURE

During a casting operation a teeming ladle is moved relatively horizontally in the X direction and vertically in the Z direction and pivoted about rotational axis A. Thus it becomes possible during automatic casting always to maintain the theoretical fulcrum of the spout about which the teeming ladle is pivoted while maintaining a safety margin between the teeming ladle and the mold at the lowest possible position.

[(Without Figure)]